



Johnson Space Center

Engineering Directorate

**EMU AG-ZN BATTERY WET-LIFE
EXTENSION TEST**

Propulsion and Power Division

B.J. Bragg **10/29/91**

**EMU AG-ZN BATTERY
WET-LIFE EXTENSION TEST**

BY

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AND

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NASA JOHNSON SPACE CENTER

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AGENDA

- EMU BATTERY DESCRIPTION
- BACKGROUND - REASON FOR TEST
- TEST OBJECTIVES
- TEST DESCRIPTION
- RESULTS/CONCLUSIONS



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EMU AG-ZN BATTERY DESCRIPTION

- 11 CELL BATTERY OF ~ 30 AH, WEIGHING 10 LBS
- TWO 4-CELL MONOBLOCKS, ONE 3-CELL MONOBLOCK
- DIMENSIONS: 10.5" LONG X 4.89" HIGH X 2.87" DEEP
- RATED FOR 8, 26.6 AH CYCLES WITHIN 135 DAYS WET-LIFE
- POWERS SPACE SUIT BACKPACK AT 3.8 AMPS FOR 7 HOURS TO 16.0 END V
- BATTERY COST IS ~ \$26K
- PRIMARY SEPARATOR IS 4 TURNS OF C-19
- CELL MONOBLOCKS ARE MANUFACTURED BY YTP
- BATTERY IS ASSEMBLED BY HAMILTON STANDARD (EMU VENDOR)
- BATTERY IS DELIVERED DRY WITH ACTIVATION KITS TO JSC



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BACKGROUND - REASON FOR TEST

- FEW PLANNED EVA'S IN CURRENT SHUTTLE FLIGHT SCHEDULE
- CONTINGENCY EVA REQUIREMENT
 - POTENTIALLY 3 EVA'S REQUIRED PER MISSION
 - 7 HOURS/MISSION @ 3.8 AMPS (26.6 AH/EVA)
- CURRENT WET-LIFE OF 135 DAYS SUPPORTS 2 VEHICLES; EVERY OTHER FLT
 - ASSUME SHUTTLE FLIGHT SCHEDULE OF 12 FLIGHTS/YEAR
 - DELTA 20 DAYS ACTIVATION/FORMATION CYCLING PERIOD
 - DELTA 10 DAY SHIPPING/INSTALLATION LEAD TIME
 - ASSUME NO USE ON FIRST VEHICLE SUPPORT
 - DELTA 60 DAYS TO SUPPORT 2ND VEHICLE; CUMULATIVE 90 DAYS
 - THUS; 135 DAY WET-LIFE DOES NOT SUPPORT A 3RD VEHICLE IN 60 DAYS
- TO SUPPORT 3RD VEHICLE; DELTA 60 DAYS FROM 2ND WITH 16 DAY MISSION
 - CUMULATIVE 150 DAYS PLUS 16 DAYS REQUIRES 166 DAYS WET-LIFE
- TO SUPPORT 4 VEHICLES; ANOTHER DELTA 60 DAYS REQUIRES 226 DAYS



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TEST OBJECTIVES

- **PRIMARY TEST OBJECTIVE**
 - INCREASE VEHICLE SUPPORT FROM 2 TO 3
 - DEMONSTRATE CAPABILITY OF THREE 26.6 AH CYCLES
 - DESIGN TEST FOR CUMULATIVE WET-LIFE OF 166 DAYS
- **SECONDARY TEST OBJECTIVE**
 - POTENTIALLY INCREASE VEHICLE SUPPORT TO 4 VEHICLES
 - PERFORM ADDITIONAL 3 CYCLES AT 226 DAYS
 - THIS OBJECTIVE PERTURBED BY 3 PREVIOUS CYCLES AT 166 DAYS



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TEST DESCRIPTION

- TEST ARTICLES ARE FLIGHT BATTERIES WITH >135 DAYS WET-LIFE
- BATTERY SPEC REQUIRES CONDITIONING CYCLE(S) FOR CHARGED STAND OF > 85 DAYS
 - EACH MISSION NORMALLY REQUIRES CONDITIONING CYCLE(S)
 - EIGHT CYCLE SPEC MUST COUNT CONDITIONING CYCLES
- TOP CHARGE AT 1.55 AMPS FOR 10 MINUTES (OR TO 21.8 V) BEFORE DISCHARGE
- DISCHARGE AT CONSTANT CURRENT OF 3.8 AMPS TO AN END VOLTAGE OF 16.0 V (MUST BE \geq 7 HOURS; \geq 26.6 AH)



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TEST RESULTS/CONCLUSIONS

- NINE BATTERIES HAVE BEEN TESTED FROM FOUR FLIGHT SHIPSETS FROM JAN '89 TO THE PRESENT
- ALL NINE HAVE SUCCESSFULLY PASSED THE 3-CYCLE REQUIREMENT AT 166 DAYS WET-LIFE
- THREE HAVE FAILED THE 3-CYCLE REQUIREMENT OF 226 DAYS
- FOUR HAVE PASSED THE 3-CYCLE REQUIREMENT OF 226 DAYS
- TWO ARE PROJECTED TO PERFORM THE 226-DAY 3-CYCLE REQUIREMENT STARTING NOV 11, 1991
- TWO MORE BATTERIES ARE SCHEDULED FOR TESTING FROM A FUTURE FLIGHT
- IT IS EXPECTED THAT THE WET-LIFE SPEC CAN BE INCREASED FROM 135 DAYS TO 166 DAYS ON THE BASIS OF THESE TEST RESULTS

BATTERY SERIAL NO.: 1143
 DEPTH OF DISCHARGE: 100%
 DISCHARGE CURRENT: 3.8 amps

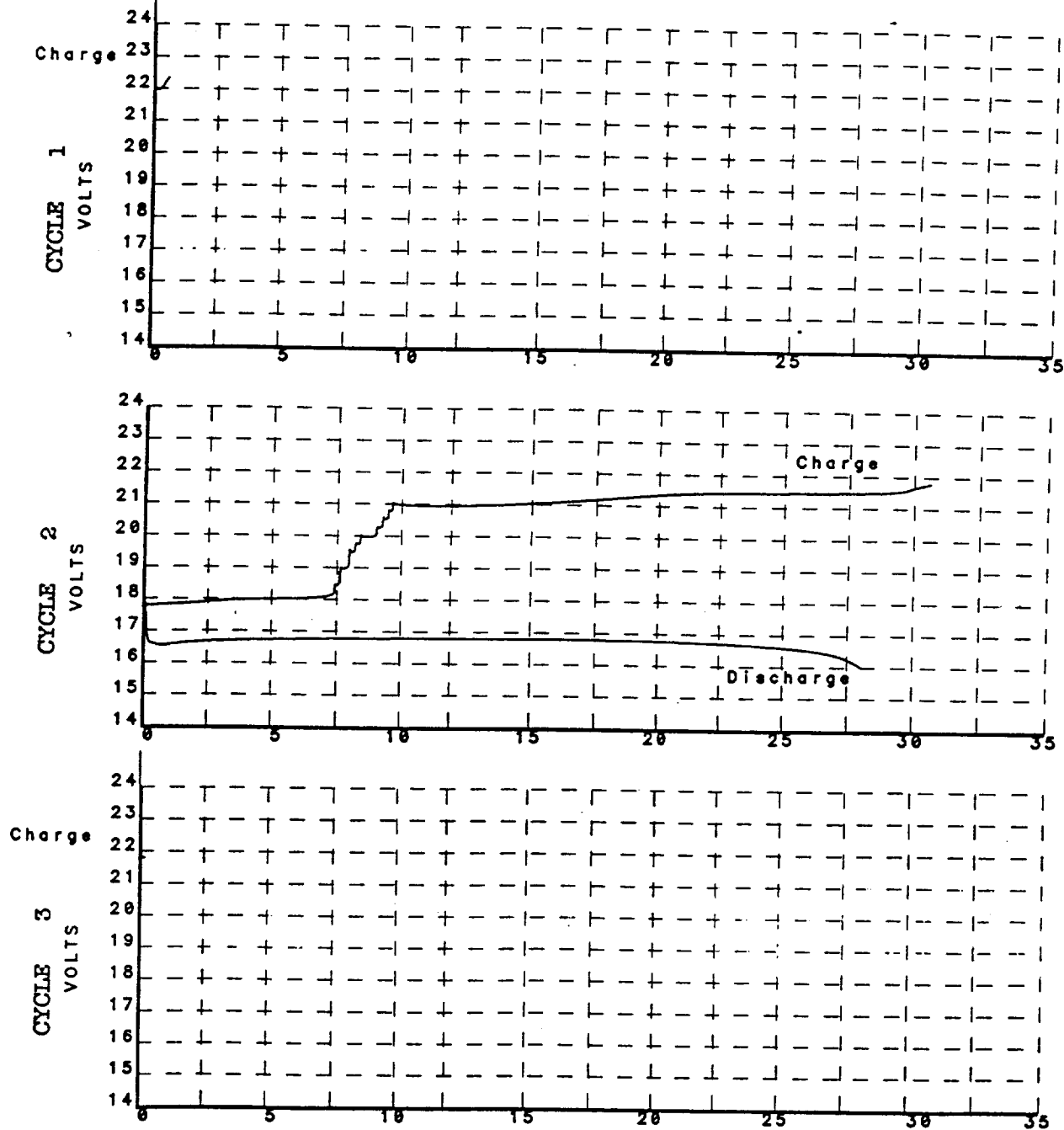
TEST 2P323, BMU SILVER-ALKALINE SECONDARY BATTERY EVALUATION

BATTERY MFG.: Yardney

BATTERY TYPE: BMU

TEST MGR.: C. M. WOOTEN

CHARGE CURRENT: 1.55 amps



Cycle #	Type Test
1	Conditioning Topping Charge
2	Conditioning Cycle
3	Topping Charge

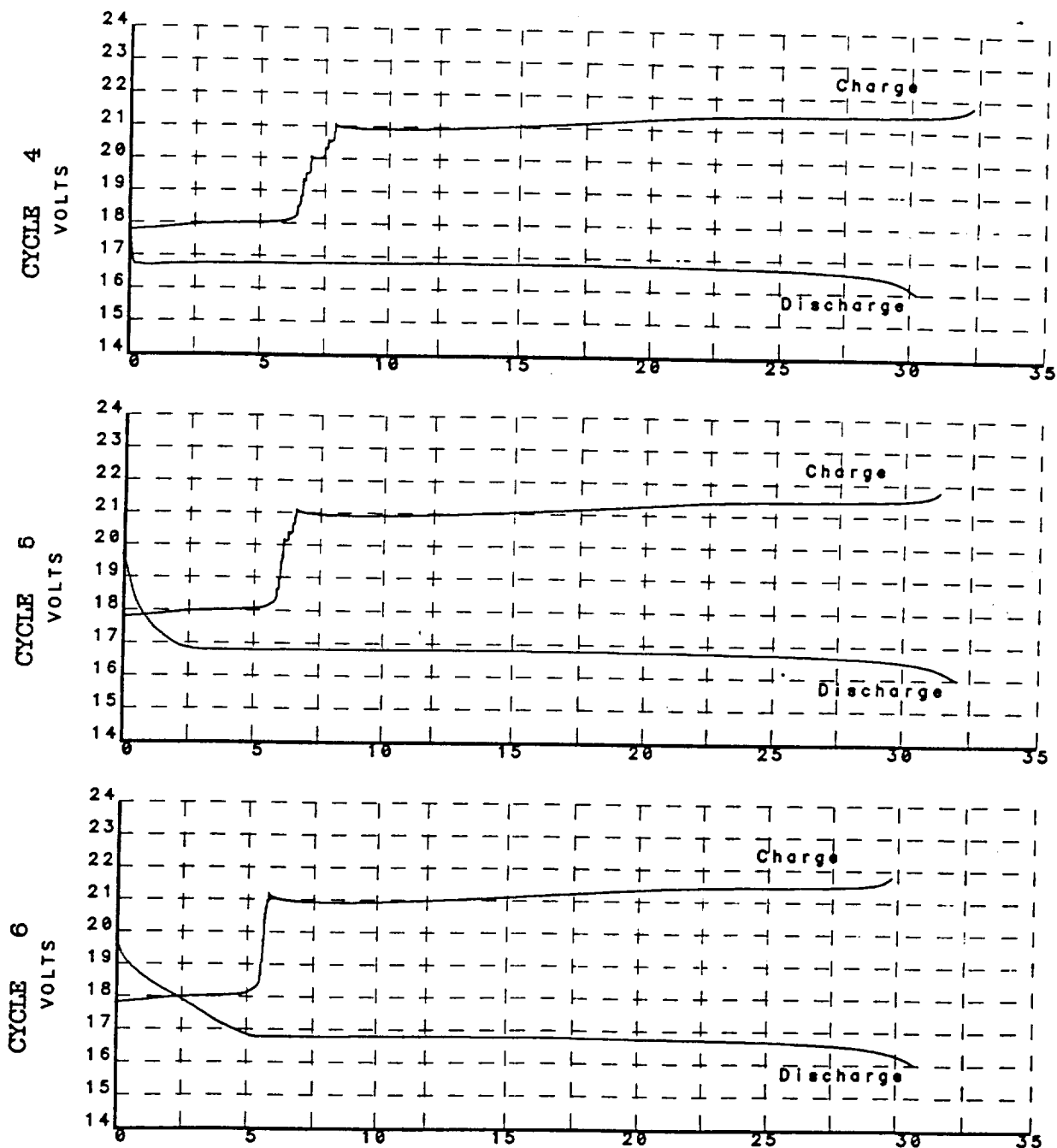
(176 Day Wet-Life)

BATTERY SERIAL NO.: 1143
 DEPTH OF DISCHARGE: 100%
 DISCHARGE CURRENT: 3.8 amps

TEST 2P323, EMU SILVER-ALKALINE SECONDARY BATTERY EVALUATION

BATTERY MFG.: Yardney
 TEST MGR.: C. M. WOOTEN
 CHARGE CURRENT: 1.55 amps

BATTERY TYPE: EMU



Cycle #	Type Test
4	Test Cycle
5	Test Cycle
6	Test Cycle

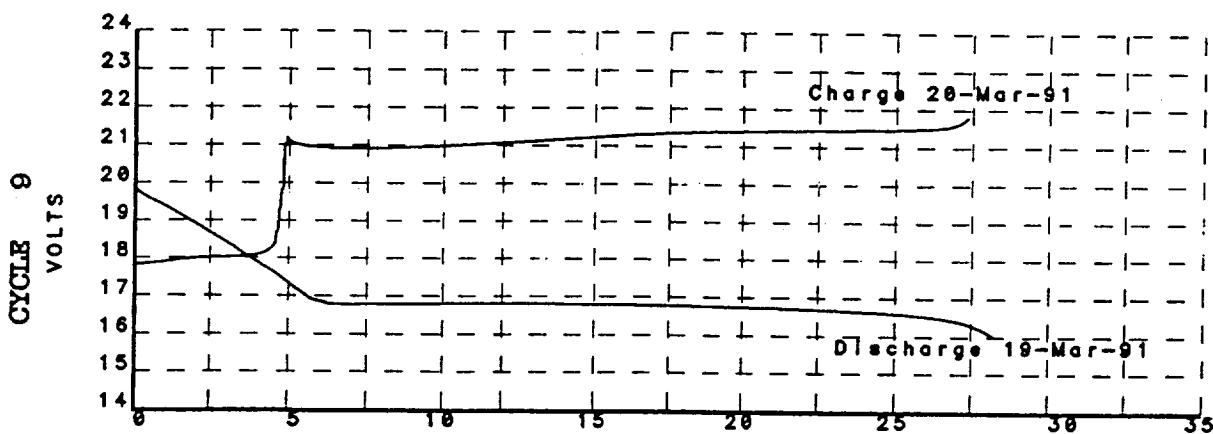
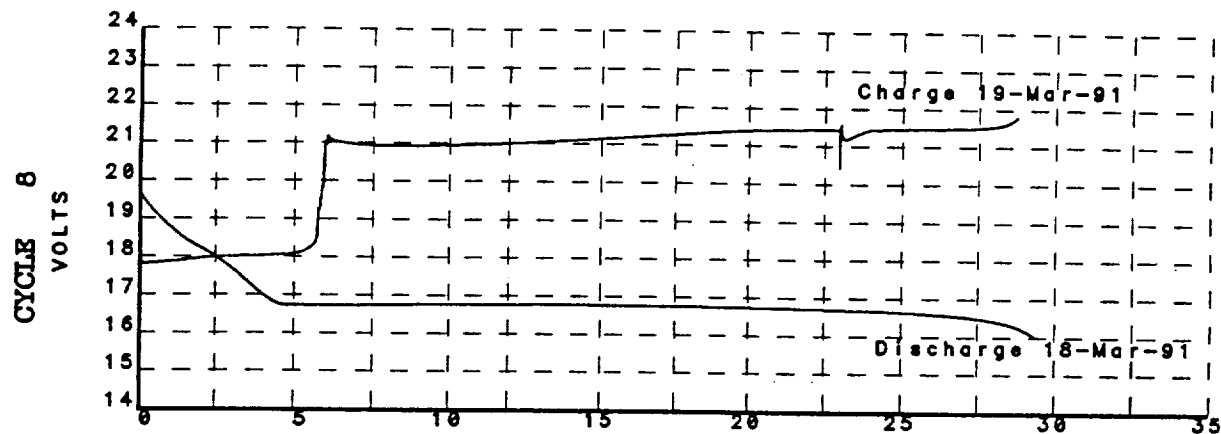
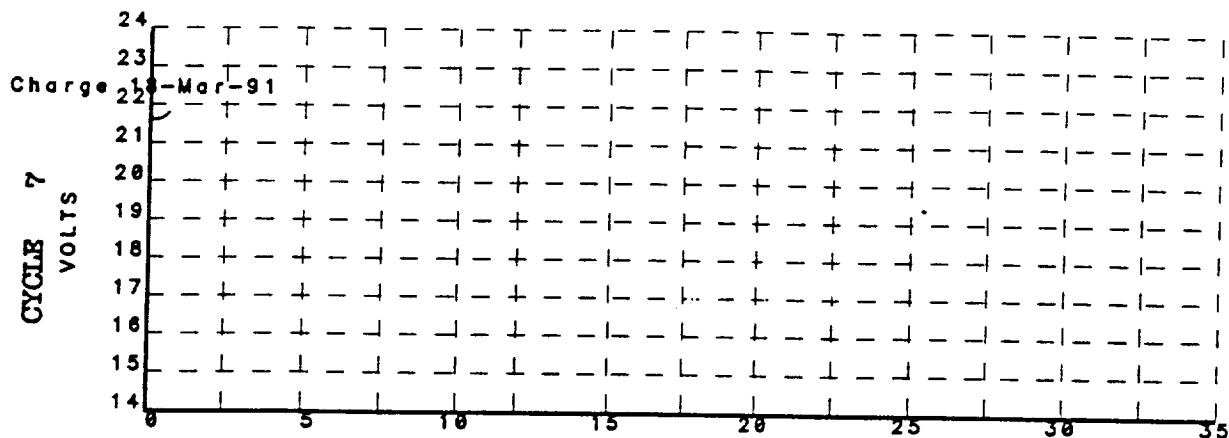
(176 Day Wet-Life)
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BATTERY SERIAL NO.: 1143
 DEPTH OF DISCHARGE: 100%
 DISCHARGE CURRENT: 3.8 amps

TEST 2P323, EMU SILVER-ALKALINE SECONDARY BATTERY EVALUATION

BATTERY MFG.: Yardney
 TEST MGR.: C. M. WOOTEN
 CHARGE CURRENT: 1.55 amps

BATTERY TYPE: EMU



Cycle #	AMP HOURS	Type Test
7		Topping Charge
8		Test Cycle
9		Test Cycle

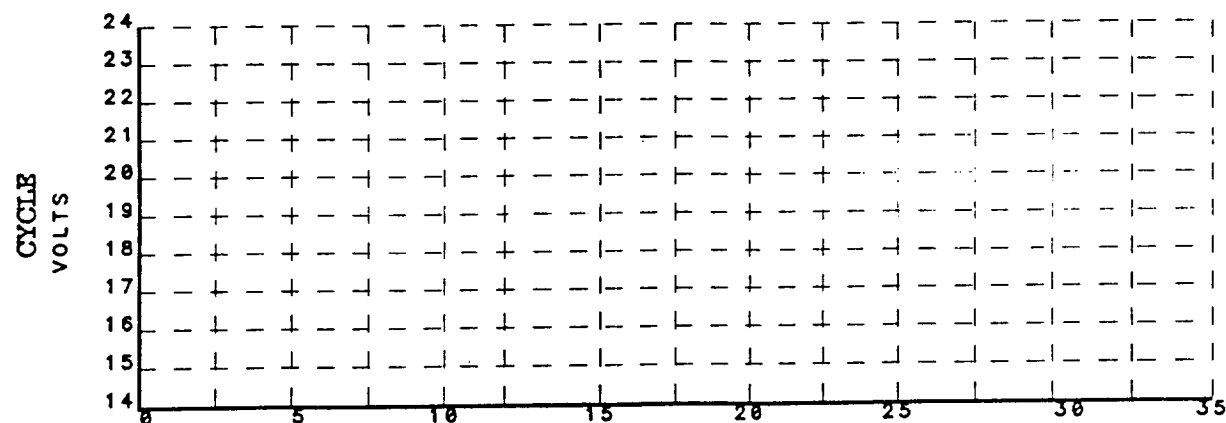
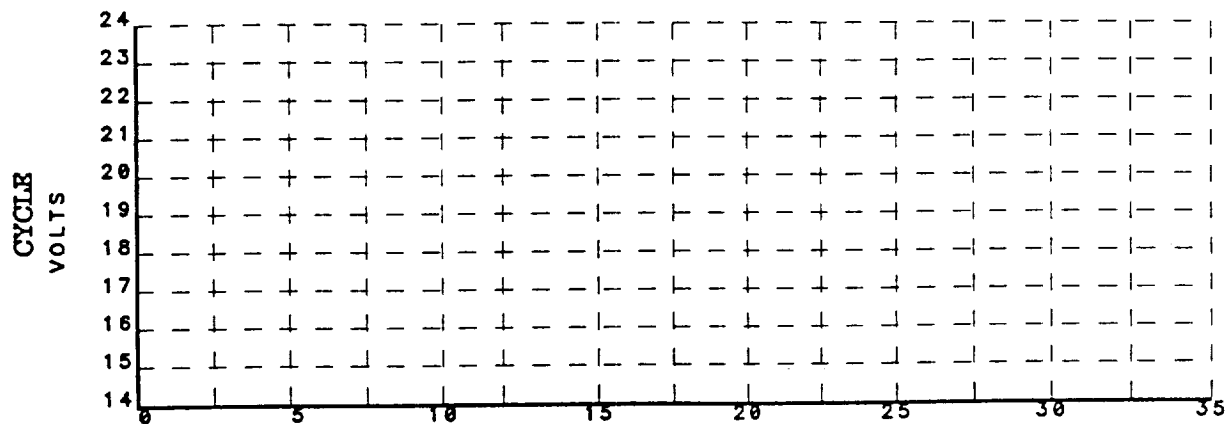
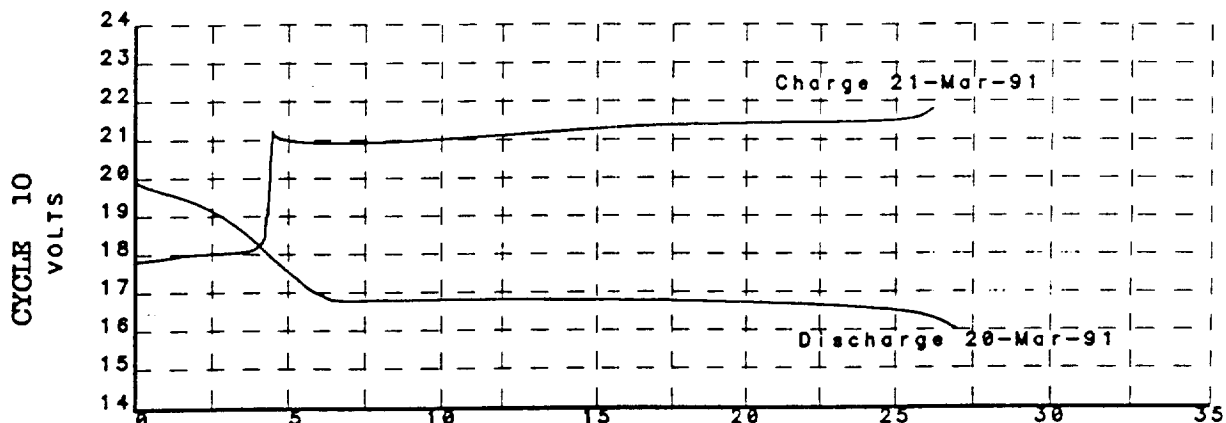
(226 Day Wet-Life)

TEST 2P323, EMU SILVER-ALKALINE SECONDARY BATTERY EVALUATION

BATTERY SERIAL NO.: 1143
 DEPTH OF DISCHARGE: 100%
 DISCHARGE CURRENT: 3.8 amps

BATTERY MFG.: Yardney
 TEST MGR.: C. M. WOOTEN
 CHARGE CURRENT: 1.55 amps

BATTERY TYPE: EMU



<u>Cycle #</u>	<u>Type Test</u>
10	Test Cycle

(226 Day Wet-Life)

Test 2P323, BMJ Silver-Alkaline Secondary Battery Evaluation

Battery Serial No.: 1143

Battery Mfg.: Yardney

Battery Type: BMJ

Depth of Discharge: 100%

Test Mgr.: C. M. Wooten

Discharge Current: 3.8 amps

Charge Current: 1.55 amps

Test End Date: 21-Mar-91

